Berkeley Lab Site Modeling

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RESEARCH OBJECTIVES

In the late 1980s, groundwater contamination was detected at the original site of Berkeley Lab (Old Town Area). A detailed investigation was conducted to locate the source and extent of the contamination. Interim corrective measures were initiated where appropriate and required, typically directed towards removing the source of contamination and installing groundwater collection trenches downstream of the plumes, limiting further spreading of contaminants. To provide a basis for predicting the fate of contaminants, we developed a transient groundwater flow model for the complex hydrogeological situation in this area. The objective of this work is to improve our understanding of flow patterns and contaminant transport in the Old Town Area, to support the decision-making processes for remediation measures.

APPROACH

In addition to the complex hydrogeology—featuring several geologic units with strongly varying thicknesses, slopes, and properties—groundwater flow is strongly affected by seasonal patterns, by local recharge from leaking storm drains, and by significant water recharge from steep hills located in the upstream direction. A hydrogeologic model was developed from geologic information obtained from more than 100 boreholes and outcrop maps. Boundary conditions for this model were established from water levels collected from a large set of monitoring wells, subdrains, and deep trenches. Distribution of hydraulic conductivity was initially assigned based on the data compiled from single- and multiwell pumping tests. Recharge to groundwater was initially estimated from the type of land surface coverage (i.e., paved, under the building, or irrigated areas). Subsurface utility maps were also employed to locate and estimate potential leakage from corroded storm drains. Subsequently, some of the input data were adjusted, using calibration techniques enabling a very accurate hydrography of a large set of monitoring wells. Calibration was performed based on 1994–1996 water levels. The calibrated flow model was validated using a blind model prediction conducted for the period of July 1996–June 2000. A refined model was subsequently developed for the central area of the main contaminant plume. This refined model will be used as a tool to analyze and improve the current hydraulic measures conducted for contaminant remediation.

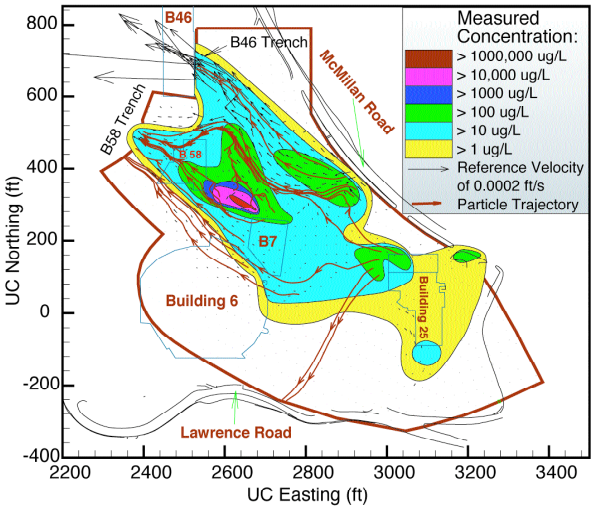

Figure 1. Simulated particle trajectories originating from contaminant plumes at steady-state flow rate (April 1998)

ACCOMPLISHMENTS

The calibrated hydrogeologic properties and recharge rates produced good agreement between the simulated and measured water table at about 40 observation wells and the flow rate at two water collection trenches. The calibrated "effective" porosity, which is much smaller than the actual physical porosity, represents the bulk effect of thin layers of relatively high hydraulic conductivity and large porosity, found in the mixed unit within bedrock of otherwise very low conductivity and porosity. This effective porosity thus leads to fast responses to water table changes with strong seasonal fluctuations. The validation results indicate that the developed model can accurately predict the complex groundwater flow at the Berkeley Lab site. Figure 1 shows the simulated velocity field and particle trajectories at July 1998, together with measured concentration contours. The simulated advective transport patterns and the measured extent of the plume are in good agreement.

SIGNIFICANCE OF FINDINGS

The developed model predicts groundwater flow in complex geological structures (ones with sharp changes in interfaces and water table gradients). It can improve our understanding of contaminant transport at the Berkeley Lab site and help us make better decisions about remediation measures for the Berkeley Lab Remediation Project.

RELATED PUBLICATIONS

Javandel, I., RCRA Facility Investigation Report, Module B, Lawrence Berkeley National Laboratory, Berkeley, California, 2000.

Zhou, Q., J. T. Birkholzer, I. Javandel, and P. D. Jordan, Simulation of Groundwater Flow at the LBNL site Using TOUGH2, LBNL-52512, Proceedings of TOUGH Symposium 2003, Berkeley, California, 2003.

ACKNOWLEDGMENTS

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